Relationship between income and mortality in a Canadian family practice cohort

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Abstract

Objective To examine the relationship between household income and mortality in a primary care cohort while using personal information obtained from clinical records and administrative data linkages to adjust for confounders.

Design Survey and analysis of data from several administrative databases.

Setting Toronto, Ont.

Participants Patients of an urban academic family practice who were aged between 45 and 74 and who had made at least 3 visits to the clinic between 1996 and 1997.

Main outcome measures Patients' self-reported household income. Patients' personal information obtained from clinical records and linkages to administrative data to adjust for confounders; personal information was used to adjust for health factors as confounders of the relationship between income and mortality risk.

Results Of the 1064 patients who received surveys, 519 (49%) responded. There was no significant difference in the mortality rate between nonresponders and responders. Mortality rates were lower than those in the general population throughout follow-up. Within the patient cohort, mortality rates were elevated for smokers, those who had not consumed alcohol in the year before the survey, and those who had been diagnosed with diabetes, hypertension, or cancer before the survey. After all adjustments were made, mortality rates were lower among patients in the higher-income categories than among those with lower household incomes.

Conclusion Universal health care does not eliminate income-related differentials in mortality. Differences in health-related behaviour factors are not sufficient to explain the socioeconomic mortality differences within an area. These data suggest that it is not solely personal choice related to health behaviour but that other explanations must be invoked to account for the relationship between lower household income and increased mortality rates.

Editor's key points

- This study's goal was to determine the relationship between household income and mortality risk, as well as to confirm or refute the hypothesis that most of the variation in life expectancy is related to differences in health-related behaviour factors, including smoking, obesity, and exercise.
- This study's cohort was a group of regular patients at an academic family practice in Toronto, Ont. This study found that, compared with the general population of Ontario, mortality rates among these patients were lower than the provincial average. However, within the cohort, patients with lower incomes had higher mortality rates than patients with higher incomes did. Patients were, on average, wealthier than the general population, and the overall decreased mortality, as well as the within-cohort income-mortality gradient, is consistent with previous observations that mortality rates are higher among those with lower incomes.
- The contribution of this research is that it is a study of people who were all covered by universal health insurance, who were all in contact with the health care system, and for whom individual data about health-related behaviour and comorbidities were obtained by survey and by linkage to administrative records.

Points de repère du rédacteur

- Le but de cette étude était d'établir une relation éventuelle entre le revenu familial et le risque de mortalité, mais aussi de confirmer ou de réfuter l'hypothèse que les différences d'espérance de vie dépendent de facteurs comportementaux en lien avec la santé, comme le tabagisme, l'obésité et l'exercice.
- La cohorte de cette étude était composée de patients réguliers d'une clinique universitaire de médecine familiale de Toronto, Ontario. L'étude a observé que le taux de mortalité de ces patients était inférieur à la moyenne provinciale. Toutefois, les membres de la cohorte qui avaient un revenu plus bas avaient un taux de mortalité supérieur à celui des mieux nantis. En moyenne, les patients de la cohorte avaient un revenu plus élevé que la population générale, et la diminution générale de la mortalité, de même que le gradient du rapport revenu-mortalité à l'intérieur de la cohorte, confirment certaines observations antérieures selon lesquelles le taux de mortalité est plus élevé chez les moins bien nantis.
- La contribution de cette étude réside dans le fait que tous les membres de la cohorte étaient couverts par l'assurance santé universelle, qu'ils étaient tous en contact avec le système des soins de santé, et que les données individuelles concernant les comportements et les comorbidités en rapport avec la santé pouvaient être obtenues à l'aide de l'enquête et d'une comparaison avec des données administratives.

La relation entre le revenu et le risque de mortalité dans une cohorte de patients d'une clinique de médecine familiale canadienne

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Résumé

Objectif Établir une relation éventuelle entre le revenu familial et la mortalité dans une cohorte de patients d'une clinique de soins primaires, à l'aide de renseignements personnels tirés des dossiers cliniques et la corrélation avec des données administratives afin de tenir compte des facteurs confondants.

Type d'étude Une enquête et une analyse des données de plusieurs bases de données administratives.

Contexte Toronto, Ontario.

Participants Des patients d'une clinique universitaire urbaine de médecine familiale âgés de 45 à 74 ans qui avaient visité la clinique au moins 3 fois entre 1996 et 1997.

Principaux paramètres à l'étude Le revenu familial déclaré par le patient. Les renseignements sur les patients tirés des dossiers cliniques et la corrélation avec les données administratives afin de tenir compte des facteurs liés à la santé qui pourraient agir comme facteurs confondants dans la relation entre le revenu et le risque de mortalité.

Résultats Sur les 1064 patients qui ont reçu le sondage, 519 ont répondu (49 %). Il n'y avait pas de différence significative de mortalité entre les répondants et les non-répondants. Les taux de mortalité étaient inférieurs à ceux de la population générale durant tout le suivi. Parmi les membres de la cohorte, le taux de mortalité était plus élevé chez les fumeurs, chez ceux qui n'avaient pas consommé d'alcool durant l'année précédant le sondage, et chez ceux qui avaient eu un diagnostic de diabète, d'hypertension ou de cancer avant l'enquête. Une fois tous les ajustement effectués, les taux de mortalité étaient plus bas chez les patients qui avaient les meilleurs revenus par rapport à ceux qui étaient moins bien nantis.

Conclusion L'existence d'un système universel des soins de santé au Canada n'empêche pas l'existence de différences de mortalité liées au revenu. Des différences dans les facteurs comportementaux liés à la santé ne sont pas suffisants pour expliquer les différences de mortalité d'ordre socioéconomique dans une région. Les présentes données donnent à penser que ce n'est pas uniquement le comportement d'une personne en matière de santé qui rend compte de la relation entre un revenu familial inférieur et un taux de mortalité plus élevé.

In North America, mortality rates are higher among individuals of lower socioeconomic status than among those of higher status. In 2016, Chetty and colleagues[1] reported that in the United States the association between life expectancy and income varied substantially across areas, and that the differences in life expectancy were correlated with health-related behaviour factors and local area characteristics. Health-related behaviour factors were not measured directly, but were inferred by income quartile using the Behavioural Risk Factor Surveillance System from 1996 through 2008. These factors included rates of current smoking, obesity (defined by body mass index [BMI]), and self-reported exercise during the past month. Chetty et al concluded that most of the variation in life expectancy across areas was related to differences in factors related to health behaviour, including smoking, obesity, and exercise.[1]

In Canada, the population's medical care is covered by government-operated universal health insurance programs, and Canadians have access to medical care irrespective of their incomes. Indeed, an analysis of data from the National Population Health Survey found that use of physicians' services in Ontario was based on need rather than income.[2] However, using data from Canada's census or national health surveys, Canadian researchers have observed that despite universal health insurance, mortality rates are higher among individuals of lower socioeconomic status compared with those of higher socioeconomic status.[3,4] However, these Canadian analyses did not have access to personal health information.

In this article I report the results of a study of mortality among individuals who, in 1998, were all regular patients of an urban academic family practice in Toronto, Ont. All of these individuals were engaged with the health care system and had access to care as required. The focus of this article is thus the relationship between household income and mortality among individuals who were covered by universal health insurance and for whom information about health-related behaviour factors and comorbidities was obtained by survey and by linkage to administrative databases. This personal information was used to adjust for health behaviour factors as confounders of the relationship between income and mortality risk. The goal was to confirm or refute the conclusion of Chetty and colleagues[1] that most of the variation in life expectancy is related to differences in health-related behaviour factors, including smoking, obesity, and exercise.

Methods

Patients and the survey

In 1998, a survey was mailed to all patients of the Family Medicine Centre at Mount Sinai Hospital in Toronto who were 45 to 74 years of age and who had made at least 3 visits to the clinic between 1996 and 1997. (These patients were considered "regular patients.") The survey included questions about health problems and about personal matters including use of tobacco and alcohol, education, place of birth, and household income. Body mass index was computed from self-reported height and weight. Self-reported smoking history was categorized as having ever or never smoked. Alcohol consumption was categorized by weekly consumption within the previous year.

Ascertainment of comorbidities and outcomes

Cohort patients were linked to several administrative databases using their Ontario Health Insurance Plan (OHIP) numbers as the identifier. These databases included the following: the OHIP billing database, 1992 to 2006, providing a record of all physician services (with a diagnostic code for each visit); the Ontario Drug Benefit database; and the Ontario Discharge Abstract Database. Patients were also linked to the Ontario Mortality Registry using a probabilistic linkage algorithm using the complete name and date of birth as the identifiers. Patients' postal codes were linked to Canada's census information to obtain median neighbourhood income data. The linkage to the OHIP database was used to ascertain diagnoses of hypertension and diabetes in the 6 years, from 1992 to 1998, before the survey. Quan and colleagues' algorithm was used to diagnose hypertension (ie, 2 claims within 2 years or 1 hospitalization).[5] Individuals were diagnosed with diabetes if they had diabetes listed as a diagnosis in 1 hospital discharge abstract or 2 OHIP claims within a 2-year period between 1992 and 1998.[6]

Statistical methods

Imputation of missing data. Some data elements were incomplete, particularly self-reported household income; 20% of women and 15% of men chose the survey option to keep their income private rather than to report an income amount. Data were also missing to compute the BMI of 8% of patients. Missing data elements were imputed with multiple imputation using chained equations,[7] as implemented in Stata statistical software, version 14.[8] The imputation model included the outcome variable (mortality) and, as recommended by White et al, the follow-up time and the Nelson-Aalen estimate of the cumulative hazard function.[7] Census values for the median neighbourhood household income were included to assist with the imputation of self-reported household income. Fifty imputed data sets were created for analysis.

Relative survival. Relative survival between the clinic population and the general population of Ontario was computed using age- and sex-specific Ontario mortality rates.

Predictors of mortality during follow-up. The relationships between personal factors and household income were studied with linear regression (BMI measurement), logistic regression (smoking status), or ordered logistic regression (alcohol consumption). The relationship between mortality and personal factors was analyzed with Cox proportional hazard regression models.[9] Tests of the proportional hazards assumption were made by examining plots of the log-log survival curves.

An ethics committee at the University of Toronto approved the study.

Results

Study population

The survey was mailed to 1064 patients (668 women and 396 men), and 519 (49%) of them responded. Because the entire clinic population had been linked to the mortality registry for an air pollution study,[10] it was possible to compare the mortality rates of nonresponders and responders. There was no significant difference in the mortality rate between nonresponders and responders (rate ratio of 1.08; 95% CI 0.68 to 1.71).

Table 1 gives the distribution of patient demographic characteristics and health profiles. The patient cohort was relatively affluent, with about half the population reporting household incomes exceeding $80 000 (the median household income in Canada was about $50 000 in 1998).

The catchment area of the clinic, located in downtown Toronto, was broad. **Figure 1** shows that study subjects lived throughout the metropolitan Toronto area.

Health-related behaviour and personal factors

Table 2 shows the self-reported health-related behaviour factors by sex and income. There was no difference in BMI (centred) by income among men, but higher-income women had lower BMIs than did lower-income women. There was no significant difference by income in the odds of having ever smoked daily (odds ratio [OR] of 1.22; 95% CI 0.85 to 1.75), but lower-income patients were more likely to be current smokers (OR = 2.87; 95% CI 1.58 to 5.21). Lower-income patients were less likely to have consumed alcohol in the previous year (OR = 0.39; 95% CI 0.24 to 0.63), to have been born in Canada (OR = 0.76; 95% CI 0.53 to 1.09), or to have graduated

Table 1. Patient demographic characteristics

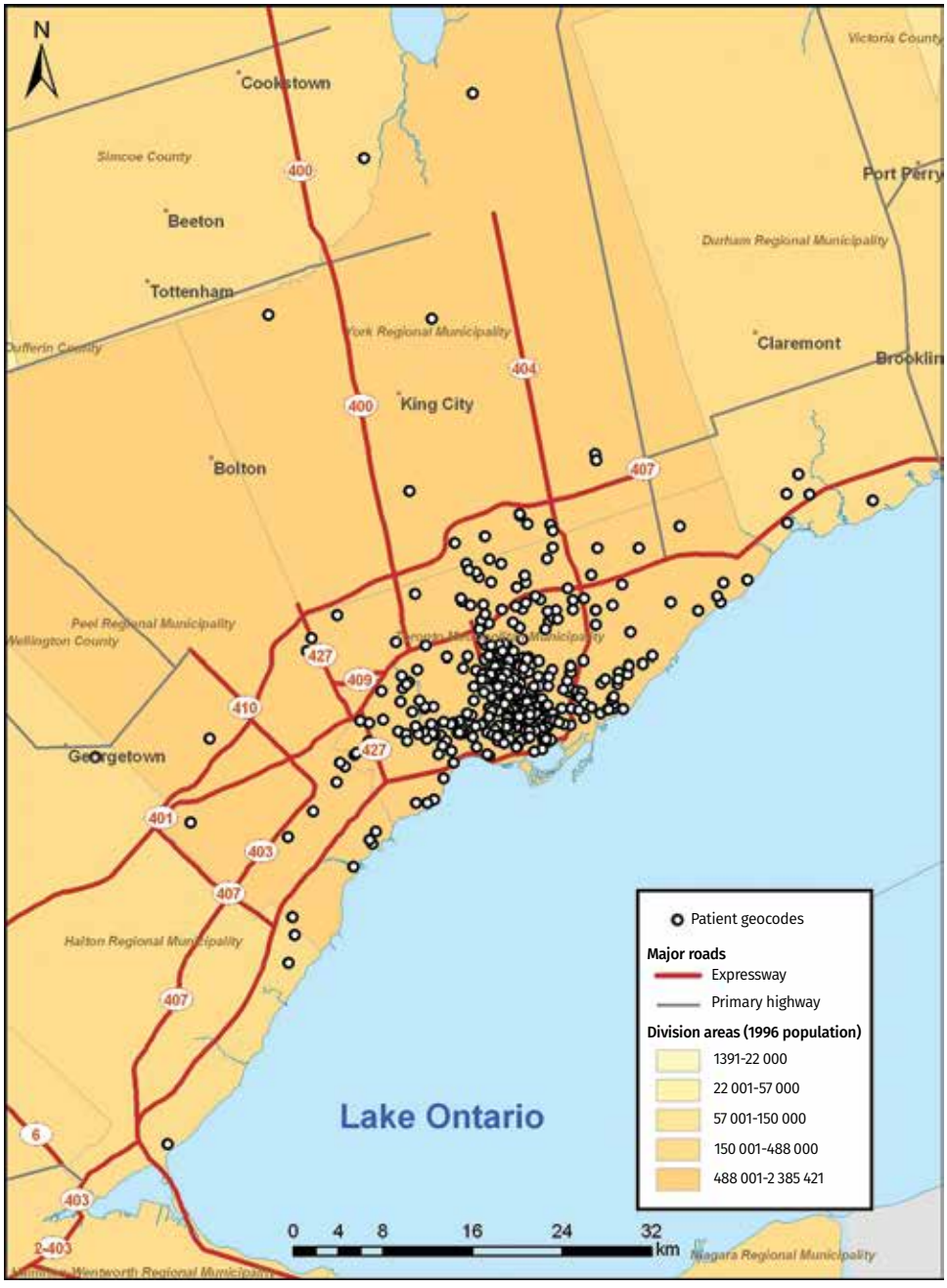
CHARACTERISTICS	FEMALE PATIENTS (N = 317)	MALE PATIENTS (N = 202)
Median (IQR) age, y	58 (50 to 67)	62 (52 to 69)
Median (IQR) BMI, kg/m^2	24.3 (22.1 to 27.7)	25.7 (23.6 to 27.4)
Median (IQR) neighbourhood income (based upon postal code linkage to census), $	46 000 (35 000-63 000)	48 000 (34 000-62 000)
High school graduate, n (%)	267 (86)	162 (83)
Born in Canada, n (%)	176 (56)	107 (53)
Alcohol use in the year before the survey, n (%)		
• None	57 (18)	24 (12)
• ≤ 1 per week	151 (48)	81 (41)
• ≥ 1 per week	106 (34)	95 (48)
Ever smoked cigarettes, n (%)	176 (56)	133 (66)
Cancer diagnosis,* n (%)	77 (24)	59 (29)
Hypertension,* n (%)	134 (42)	76 (38)
Diabetes,* n (%)	39 (12)	37 (18)
Household income per annum (imputed), n (%)		
• < $20 000	35 (11)	20 (10)
• $20 000 to < $40 000	50 (16)	30 (15)
• $40 000 to < $60 000	47 (15)	25 (12)
• $60 000 to < $80 000	35 (11)	18 (9)
• ≥ $80 000	150 (47)	109 (54)
Categorical income of < $60 000 per annum, n (%)	132 (42)	75 (37)

BMI—body mass index, IQR—interquartile range.
*Before the survey.

from high school (OR=0.25; 95% CI 0.15 to 0.44). Lower-income patients were substantially more likely to have been diagnosed with diabetes (OR=1.99; 95% CI 1.21 to 3.29). After adjustment for age and sex, there were no significant associations between household income and the prevalence of a diagnosis of hypertension (OR=1.18; 95% CI 0.81 to 1.71) or cancer (OR=0.80; 95% CI 0.53 to 1.21).

The diagnoses of hypertension (OR=1.10 per unit increase in BMI; 95% CI 1.05 to 1.16) and diabetes (OR=1.12 per unit increase in BMI; 95% CI 1.06 to 1.18) were both associated with BMI. There was no association between the diagnosis of cancer and BMI. High school graduates were less likely to have been diagnosed with hypertension (OR=0.62; 95% CI 0.37 to 1.02) or diabetes (OR=0.27; 95% CI

Figure 1. Residence locations of the study patients: *Each patient is represented by a circle. The clinic is located in downtown Toronto, Ont.*



0.15 to 0.49). There was no association between being born outside of Canada and hypertension or diabetes.

Survival rates

Figure 2 shows the relative survival of cohort patients compared with the general population of Ontario during 9 years of follow-up. Mortality rates in the cohort were lower than those in the general population throughout follow-up, reaching a 9% survival advantage after 9 years.

Factors associated with mortality

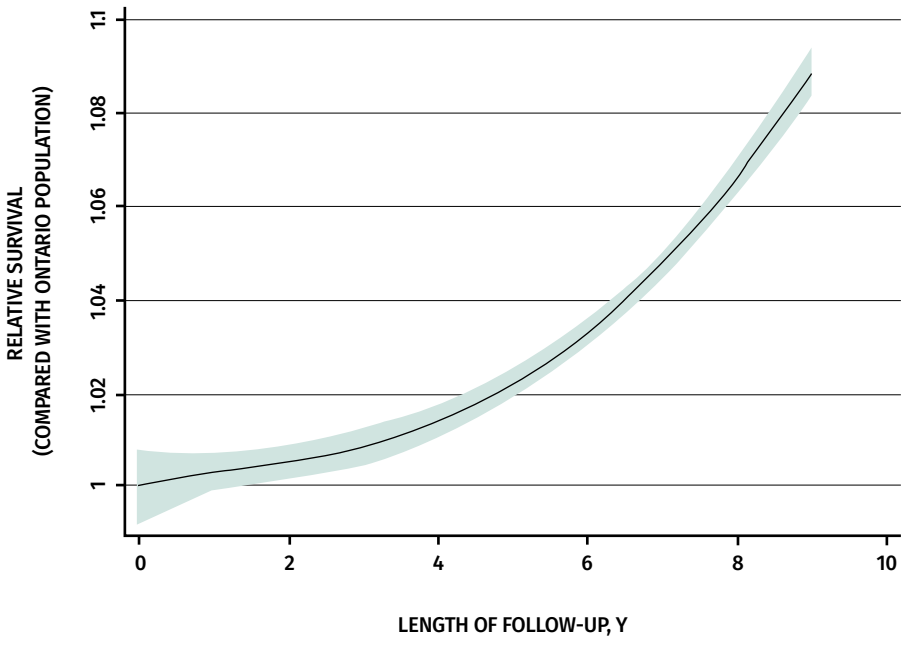
The associations between income and variables representing health-related behaviour factors, personal factors, and comorbidities were examined with Cox regression models. Because the imputation process for missing data created multiple data realizations, the coefficients were computed by averaging 50 regression models. Because the number of deaths was relatively small (30 among men and 24 among women) and the number of covariates was relatively large, variables

Table 2. Health-related behaviour and personal factors, by income and sex

	INCOME < $60 000		INCOME ≥ $60 000	
HEALTH-RELATED BEHAVIOUR AND PERSONAL FACTORS	MALE	FEMALE	MALE	FEMALE
BMI (centred), kg/m^2, mean (95% CI)	0.29 (-0.5 to 1.1)	1.32 (0.2 to 2.5)	0.24 (-0.4 to 0.8)	-0.99 (-1.6 to -0.4)
Ever smoked daily, % (95% CI)	63 (52 to 74)	52 (43 to 60)	57 (48 to 65)	46 (39 to 53)
Current smoker, % (95% CI)	13 (6 to 21)	17 (11 to 24)	4 (1 to 7)	9 (5 to 13)
Never drank alcohol in the past year, % (95% CI)	20 (11 to 30)	28 (20 to 36)	9 (4 to 15)	12 (7 to 17)
Born in Canada, % (95% CI)	51 (39 to 62)	49 (41 to 58)	55 (46 to 64)	60 (53 to 67)
High school graduate, % (95% CI)	65 (54 to 76)	79 (72 to 86)	94 (89 to 98)	91 (87 to 96)
Diabetes, % (95% CI)	27 (17 to 37)	17 (10 to 23)	13 (7 to 19)	9 (5 to 13)
Hypertension, % (95% CI)	43 (31 to 54)	47 (38 to 56)	35 (26 to 43)	39 (32 to 46)
Cancer, % (95% CI)	27 (17 to 37)	25 (18 to 32)	31 (23 to 39)	24 (18 to 30)

BMI—body mass index.

Figure 2. Relative survival of the patient cohort compared with the general population of Ontario during 9 years of follow-up: *The shaded band is the 95% CI around the relative survival curve.*



were sequentially added to the statistical model, and the change in effect estimate for the income variable was observed. The income variable was first included in a model adjusted only for age and sex. Subsequently, additional covariates were added one at a time in order to monitor the stability of the estimates of the income variable. After adjustment for the smoking and alcohol-use variables, there was minimal change to the coefficient or CI for the income variable as additional covariates were added. Examination of the log-log plots showed the model to be consistent with the proportional hazards assumption. The results of the final model are presented in **Table 3**.

Women had substantially lower mortality rates than men did. As expected, those who smoked had higher mortality rates, but alcohol consumption in the year before the survey was inversely associated with mortality. There was no association between education (high school graduation or not) and mortality. Canadian-born patients had higher mortality rates than immigrants did. After adjustment for BMI, mortality rates were elevated for those who had been diagnosed with diabetes, hypertension, and cancer before the survey. Finally, after all these adjustments, mortality rates were lower among patients in the higher-income categories than those in lower-income categories.

Coding of self-reported income

Models were computed with self-reported income treated as a continuous categorical variable with 5 levels, as a categorical variable, and finally as a dichotomous variable with the cut-point at a household income of $60 000.

Table 3. The results of the regression model examining explanatory variables for mortality: *The model is adjusted for age and BMI.*

RISK FACTOR	RELATIVE RISK (95% CI)
Female vs male	0.47 (0.27 to 0.82)
Imputed income (categorical variable with 5 categories, treated as continuous from low to high income)	0.75 (0.59 to 0.96)
High school graduate vs non-graduate	1.05 (0.54 to 2.04)
Born in Canada vs immigrant	1.76 (0.99 to 3.12)
Ever smoked daily vs never smoked daily	2.17 (1.15 to 4.09)
Alcohol use during the previous year	
• > 1 drink per week	1.0 (reference)
• ≤ 1 drink per week	1.91 (0.90 to 4.02)
• None	4.22 (1.81 to 9.85)
Diabetes diagnosis before survey	2.74 (1.46 to 5.13)
Hypertension before survey	1.39 (0.76 to 2.53)
Cancer before survey	1.93 (1.07 to 3.50)

BMI—body mass index.

Table 4 shows that, in all models, mortality rates were higher among those patients with lower incomes.

Discussion

It has been observed in North America and Europe that mortality rates in the population are inversely related to income. None of the previous North American analyses has included patients' personal information regarding health-related behaviour factors and health status. The goal of this analysis was to study the relationship between household income and mortality while using personal information to adjust for potential confounders of the relationship between income and mortality risk and to confirm or refute the hypothesis that most of the variation in life expectancy is related to differences in health-related behaviour factors, including smoking, obesity, and exercise.

It was found that, compared with the general population of Ontario, mortality rates among these patients who were regular patients at an academic family practice were lower than the provincial average. However, within the cohort, patients with lower incomes had higher mortality rates than patients with higher incomes did. Patients in the cohort were, on average, wealthier than the general population, and the overall decreased mortality, as well as the income-mortality gradient within the cohort, is consistent with previous observations that mortality rates are higher among those with lower incomes. The contribution of this research is that it is a study of people who were all covered by universal health insurance, who were all in contact with the health care system, and for whom individual data about health-related behaviour and comorbidities were

Table 4. Final model with different income parameterizations

INCOME PARAMETERIZATION	RATE RATIO (95% CI)
Parameterization 1	
Categorical income (as continuous variable)	0.75 (0.59 to 0.95)
Parameterization 2	
Categorical income (by categories) per annum	
• < $20 000	1.0 (reference)
• $20 000 to < $40 000	0.81 (0.35 to 1.88)
• $40 000 to < $60 000	0.98 (0.40 to 2.42)
• $60 000 to < $80 000	0.17 (0.02 to 1.30)
• ≥ $80 000	0.34 (0.12 to 0.97)
Parameterization 3	
Income of < $60 000 per annum vs income of ≥ $60 000 per annum	2.18 (1.18 to 4.02)

obtained by survey and by linkage to administrative records. This information was used to adjust for confounding of the income-mortality relationships.

Chetty and colleagues examined 4 leading explanations for socioeconomic differences in longevity: differences in access to medical care, environmental differences (as measured by residential segregation), adverse effects of inequality (as measured by Gini indices), and labour market conditions (as measured by unemployment rates). They concluded that a lack of access to care is not the primary reason that lower-income individuals have shorter life expectancies. This is confirmed in our patient cohort, where all subjects were regular patients at the clinic and were covered by universal health insurance. Access to care is, however, more than insurance coverage, and includes concepts such as the ability to obtain medical care when needed. Some patients might have difficulty visiting the doctor because of the inability to leave work, child care responsibilities, or poor access to transportation. Beyond this, there might be a bias in referral to specialists. It has been reported that Canadians with lower incomes and fewer years of schooling visit specialists at a lower rate than do those with higher incomes and higher levels of education attained.[11] Other theories for the socioeconomic differences in mortality investigated by Chetty et al include physical aspects of the local environment, inequality or lack of social cohesion, and local labour market conditions. The patients in this study would have experienced the same local labour market conditions, but data were not available to explore the other theories.

Chetty concluded that most of the variation in life expectancy across areas was related to differences in health-related behaviour factors. Because suboptimal health behaviour dimensions are associated with increased mortality risk, it is logical that differences across areas would be related to these factors. However, analysis of this patient cohort found that personal differences in dimensions of health-related behaviour were not sufficient to explain the socioeconomic mortality differences within an area. After accounting for health-related behaviour factors, the diagnoses of hypertension and diabetes, and education and immigration status, there were still substantial differences in mortality risk associated with household income.

Limitations

There are several limitations to this study that merit discussion. The cohort size was relatively small. However, there was sufficient variation within the cohort to adequately explore household income and personal factors in relation to mortality. Personal data were obtained by survey, and the response rate was only 49%. There were, however, no substantial differences in mortality rates between responders and nonresponders. It would have required selective nonresponse by those with higher and lower incomes who would have experienced higher and lower mortality rates respectively over the next 9 years, than did the patients of similar income who responded, to introduce bias. This is unlikely.

Income data were self-reported, and about 20% of respondents chose the option to not disclose their household income. Multiple imputation was used to create 50 data sets with complete data. Multiple imputation has been found to work well, resulting in unbiased estimates of study associations.[12] For the full patient cohort, using imputed data, a relative risk of 2.18 (95% CI 1.18 to 4.02) was calculated for patients with a household income of less than $60 000. In the subset of patients with complete survey data, the corresponding relative risk was 3.84 (95% CI 1.64 to 9.01).

Finally, the last date of follow-up through administrative data linkages was 2008. This analysis was performed in 2016. It would have been desirable to update the linkages to extend follow-up. However, the Ontario Ministry of Health and Long-Term Care refused to perform an update on the grounds that privacy policy had changed and that personal approval from the study patients would have been required. This was impracticable and, in the case of those patients who had died, impossible.

Conclusion

Universal health care does not eliminate income-related differentials in mortality. Differences in health-related behaviour factors are not sufficient to explain the socioeconomic mortality differences within this cohort of primary care patients. These data suggest that it is not solely personal choice related to dimensions of health-related behaviour that account for the relationship between lower household income and increased mortality rates, but rather that other explanations must be invoked to account for these differences. Further research into possible explanations is desirable in the hope that inequities in mortality might be reduced.

Dr Finkelstein is a retired family physician who practised in the Family Medicine Centre at Mount Sinai Hospital in Toronto, Ont.

Competing interests
None declared

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